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Session II: Clinical Decision Making: Clinical Problems; How to Teach Problem Solving Strategies

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The practice of modern medicine involves the consumption and generation of so much information, in such volume and of such great complexity, that informal methods for using this information no longer suffice. Unguided by formal reasoning tools, physicians risk underutilizing the data available to them, as well as incurring unnecessary costs in the collection of data that they do not need.

Under the labels "clinical epidemiology," "decision analysis" and "biostatistics," investigators and clinicians have joined forces to generate new ways to label, use and store clinical information. Modern educational programs must provide students with a working knowledge of these quantitative reasoning tools. Four categories of knowledge seem especially pertinent.

Tests and test performance: the value of information. Parsimonious clinical work requires the physician to know when a test may be helpful, and when it may not. A well defined vocabulary exists for describing test performance features, and some of the connected concepts involve counterintuitive results.

Some test performance features describe the ability of the test to detect disease when present, or to "detect" wellness when there is no disease. *Sensitivity,* sometimes called "positivity in disease," is the probability that a truly ill person will have a positive test. *Specificity,* or "negativity in nondisease," is the probability that a well person will have a negative test result. Sensitivity and specificity change systematically with the level of test result that one chooses to use as a definition of "normality." Very stringent choices of cutoff levels are associated, for example, with high specificity; reduced sensitivity is compared with less stringent cutoff levels. For any test, the frontier of attainable pairs of sensitivities and specificities defines a line on a plane in which sensitivity and specificity can range between 0 and 1.0, and that line is known as the *receiver operating characteristic* curve (ROC curve) for the test.

The sensitivity, specificity and ROC curve for a test do not depend on the prevalence of disease in the population tests (or, in the case of a single patient, the probability of disease before the test information). Other test performance features do. The two most useful concepts are the *predictive value of a positive test* (PVP), which is the probability that a person who has a positive test result actually has the disease, and the *predictive value of a negative test* (PVN), which is the probability that a person with a negative test actually does not have the disease. Commonly, physicians confuse the sensitivity of a test with its PVP. In fact, when the prevalence of disease is low, even a test with very high sensitivity can have a low positive predictive value.

Sound texts now exist for helping students to learn about these and other test performance features, and to teach them to calculate these features from published case series, as well as from the more formal use of Bayes' theorem, whose logic underlies the mathematic relations among sensitivity, specificity, PVP, PVN and prevalence. In addition, microcomputer-based teaching programs are just becoming available; these permit interactive instruction and problem solving at the student's own pace.

Decision analysis: reducing risk and controlling cost. Determining how well a test performs is only the first step in making a decision about its use. Information costs money, and may involve risk, so it is necessary to decide when the risk and cost are worth the potential gain. The same logic applies to treatments, which are usually of uncertain efficacy in a given case. The general problem of *reasoning under uncertainty* is part of the daily life of the physician, and much effort has gone into developing the techniques of *decision analysis* and related disciplines for applications in medicine. In the past decade, decision analysis textbooks for clinical use have come into existence, and a professional society devoted to this field (The International Society for Medical Decision Making) with its own journal has grown to nearly 1,000 members.

Decision analysis uses formal calculations of expected gains and losses to help guide the selection of diagnostic tests and therapeutic strategies. It can be used both to discover strategies that minimize risk, and to elucidate the costs associated with specific strategies. In a few settings, decision analysis consultation services have arisen for "real time" assistance to physicians and patients faced with difficult choices.

Decision analysis uses the "decision tree" as a graphic display of the sequence of possible choices and probable events. "Pathways" through the tree are assigned quanti-

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tative probabilities based on scientific knowledge or the informed guesses of experts, and "end points" are assigned values or utilities representing the well-being (survival, quality of life, state of function, and so forth) of a person who happens to traverse each pathway.

Although decision analysis has not achieved widespread application in actual medical settings, it is appearing more and more frequently in clinical journals, and has been used in some health policy contexts as well. Ultimately, its acceptability may depend in part on the availability of microcomputer-based decision analysis programs, permitting users to interact directly with computerized systems for structuring their own "trees" and for inserting locally relevant probabilities and outcomes.

Psychologic issues and behavioral decision theory. Just as formal quantitative techniques have become better developed in medicine in the past decade, so has our understanding increased of the psychologic and sociologic impediments to the best possible use of information. Physicians, like all human beings, are susceptible to group pressures, which can distort information and perpetuate myths. In addition, psychologists have better defined the hazards of shortcuts used by the human mind when faced with complex information. For example, it is now well known that people tend to confuse the *memorability* of an event with its *probability*, a substitution that may not be at all warranted on objective grounds.

New elements of medical curricula may be useful to help physicians learn in advance the pitfalls in reasoning that may derive from the social contexts in which they work or from the properties of human inference itself.

Clinical epidemiology: when to believe a journal paper. The past decade has also seen the emergence of several excellent tests for students who wish to master elements of experimental design and formal inference that will help them to better consume an increasingly complex and voluminous medical literature. Evaluating the design of a published study, knowing when common statistical tests are correctly applied and identifying hidden biases are skills that can be used by any professional consumer of medical journals. Instruction in these topics and others lumped under the title "Clinical Epidemiology" must focus as much on critical thinking processes as on the formal techniques of statistics that have traditionally held some place in the medical curriculum.

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Sessions III and IV: Medical Education Information Systems: Role of Lister Hill Center in Research/Development; Demonstrations of Prototype Medical Education and Information Systems

Welcome: Harold M. Schoolman, MD; **Chairperson:** Michael Weisberg, EdD;
Panelists: Karen Armstead, MLS, Victor Carr, Jr., EdD, William Harless, PhD, Lawrence C. Kingsland III, PhD, Craig N. Locatis, PhD, Suzanne Mayse, Joseph Mingioli, James Woods, PhD

Research and development projects. The following current research and development projects relevant to technology in teaching were described and demonstrated.

The Technological Innovations in Medical Education (TIME) project is exploring the use of interactive videodisc, voice recognition and microprocessor technology to create patient simulations for medical students in all phases of their training. These educational simulations embody dramatic, engaging portrayals of the social and medical conditions of a patient. The interaction between student and simulated patient is uncued and voice controlled.

The Computer-assisted Curriculum Delivery Systems (CCDS) program has four research projects intended to explore uses of optical videodiscs and computers in health professions education. These projects are producing experimental courseware (software) in 1) basic pathology, 2)